ANALYSIS OF NESTING ACTIVITIES

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A. Introduction

In earlier articles,[1] I used the term *Instinct* as meaning a series of innately associated simple reactions of an organism. A single movement is of course instinctive, because the necessary structures for its execution are present as an inherited part of the organism; and two movements form an instinct-group, if, before the animal's reactions are modified by training, the first element serves as a stimulus that regularly conditions the second element of the group. Such a series of movements should be called a unitary 2-group; one which contains five simple elements of movement would be a unitary 5-group, etc. The groups should be called unitary because their elementary movements are in each case very similar qualitatively, i. e., in the case of a given group the elements occur in approximately the same tempo, direction, and amplitude of movement.

A simple habit is such a simple group of movements which training has caused to occur more frequently than originally. The frequency of occurrence of a group can be increased only if one or more other responses of the organism are associated with and accordingly condition, as regularly as they occur, the initial element of the group in question. Through this process, an extra number of stimuli of the animal's environment may condition more or less directly a given group that we may at the time be interested in, and, as this number of extra stimuli increases, the frequency of occurrence of the group also increases.

It has occasionally been my experience that people who observed my animals and heard me use the word instinct, or who read my articles wherein I applied the expression to very simple responses consisting of one or a very short series of elements, seemed to think that the simple little groups in question should be designated by a different term. My earlier

[1] Ueber einfache Bewegungsinstinkte und deren künstilche Beeinflussung, *Zeit. f. Sinnespsysiologie,* 1915; The Term Reaction Time Redefined, *Amer. Jour. of Psychol.,* 1917; Relevant and Irrelevant Speech Instincts and Habits, *Psychol. Rev.,* 1917.

attempt, however, in experimenting with the simple group movements, was to study the elements which I presumed constituted the traditional instincts. For my own satisfaction I then synthetically constructed imaginary and really complex instincts out of the simpler ones. This was made as a stepping stone toward an intensive study of some of the traditional instincts. In this paper, I shall attempt to show that nest construction is the result of an interplay of instinct-groups, and after that I shall attempt to indicate the rôle played by the unitary groups in producing the actions which an animal manifests in defending its nest.

In the following discussion of the nesting activities, it will be of little significance whether or not the instinct-groups are in any case habitualized, in which case they would be habits as well as instincts; for the only difference which this could make would be a quantitative one. For example, if a unitary 11-group of a cockatoo should happen to be one of those which could aid in constructing a nest, and if it were so poorly habitualized that, e. g., the last three elements would sometimes occur independently of the preceding eight, the bird would do approximately the same thing in this case as when the group occurred as a whole; in the one case the act would be only of shorter duration and accordingly only quantitatively simpler. This would necessarily be the outcome of the partial occurrence of any group because the different elements of the group are very similar qualitatively.

B. Nest Building

Relation between bodily activity and complexity of nest: Observations justify the statements that, generally speaking, the nest-building animals are the most active ones of the animal kingdom, and that those which build the most elaborate nests are the most active ones of the nest-builders. When we review the next-building vertebrates we find that the birds are the most elaborate nest-builders; and it is to be borne in mind in this connection that the birds, as a class of animals, are far more active than any other class of the vertebrate kingdom. However, if the qualification for nest-building were no more than *activity,* we should expect the albatros to build an extremely elaborate nest; but it builds no nest. The albatros is very active, being almost continually on the wing, but it is after all active in a very few general ways instead of a great many. Mere activity is accordingly not sufficient; the animal must be active in very many ways.

The next most active class of animals is the rodents, and, it is interesting that the rodents build nests which are com-

parable in elaborateness to many of those constructed by the birds.

An examination of a relatively inactive class, such as the reptiles, gives us further facts which support our present thesis. Even though the greater number of these are egg-laying animals, they build very crude nests — if one may venture to call them nests at all. The alligator, for example, leaves the water for a short distance, entrenches itself — usually in the sandy earth — deposits the eggs, and then roughly and recklessly conceals them with earth and trash. For another example, the turtle digs a hole in the sand with its hind claws, deposits the eggs, and then covers them with earth and trash. These are mere holes in the ground; and I shall not reckon them as nests in the true sense of the word, since no foreign objects are collected and fitted together in any systematic fashion.

Relative utility of the various movements: It may be the case that many of the movements manifested during the process of building a nest have, when ontogenetically or phylogenetically considered, no biological purpose; and it may also be the case that many of those manifested at the time are even harmful in nest construction. When we are concerned with a very large number of activities of a given animal, the law of probability should enable us to predict that if a few of them are of extreme biological significance in nest-building, a corresponding few should be of very little value, if of any at all, or indeed harmful. If the outcome were just this, however, the condition for nest-construction would not be met. We should suppose that a nest can be constructed only under the condition that there is an interplay of great numbers of different groups, of which the useful ones by far outnumber the harmless and harmful ones. Careful observations show that an excess of very useful ones are manifested by the more elaborate nest-builders and fewer by the animals which built the cruder nests. A preponderance of useful groups of movements, where such exists, may be attributed to the biological factor of natural selection.

Theoretical conception of nest building: The lizard builds no nest, but for the present study it is without doubt an excellent subject for observation, because many of the easily observed groups of movements which it manifests are in no essential way different from many of the responses which a bird makes while building a nest. It seems as if the only possible reason why the lizard constructs no nest is that there does not exist a preponderance of responses which blindly

serve to construct a nest more rapidly than to destroy it. For this study, I shall take some of the activities of an Australian lizard, Bearded Agama (Amphibolurus barbatus Cuv.) and arbitrarily ascribe purposes to them which will enable one to easily imagine that the animal is engaged in the construction of a nest. After considering such a theoretical nest while holding the really purposeless movements of the lizard in mind, I shall examine the nesting activities of a bird, and determine the fundamental differences — if any are to be found — which may be discovered while comparing the two cases.

In the partial synthesis of the random movements of the lizard, I shall consider three purposeless activities — they are purposeless at least in regard to nest-construction. To each of these I shall assign fictitious purposes, such as would necessarily exist if the individual responses which make up these activities really served to construct a nest. These activities or complexes of responses are: (1) nodding of the head in the tempo of 0.30 sec., (2) nodding of the head in the tempo of 2.31 sec., and (3) inflating of the so-called beard in the tempo of 0.97 sec. For the sake of convenience I shall name these three activities A, B, and C respectively, and, for reasons that will be brought out later, I shall substitute the expression *complex* for the word activity that I have heretofore used. In assigning fictitious purposes to them, I shall call complex A, walking; complex B, seizing of objects with the mouth; and complex C, head movements which serve to arrange the objects to form the nest. At present, I shall not concern myself with the choice of the building place any further than to merely suppose that the lizard is to build the nest in the neighborhood of the place where it usually suns. The following are groups of movements that constitute the complexes A, B, and C, and which the lizard performed in the course of two hours:

Complex A....	-	11	-	11	-	13,	11-	11	-	11	-	11,	13-	13-	13-	13-	13,	11	-	11-	11	-	11-								
Complex B....	-	6-		6-		-	6-		6-			-	-	-	-		6-		-	6-		-								
Complex C....	-	-		-		-	4		-4			-4	-4	-	-4		-4		-	-4		-								
		a		b		c	d	e	f			g	h	i	j		k	l		m	n		o	p							

The number 11, for example, signifies the number of elementary movements that constitute one of the unitary groups of complex A; the first group of complex B consists of six elements; and the first group of complex C is composed of four elementary movements. In the table, a dash means a pause of longer duration than fifteen seconds; a comma signifies a pause of less than fifteen seconds; and the absence of either a dash or a comma between the groups of the same or different complexes means the absence of a pause. The small arabic letters underneath indicate in cases single groups and

in other cases series of groups and pauses which we can conveniently use in our comparison. Neglecting the first long pause, the groups of the three complexes should be read, in the order that they were performed, as follows: (a) 11-group, no pause, 6-group, long pause; (b) 11-group, no pause, 6-group, long pause; (c) 13-group, short pause; (d) 11-group, long pause; (e) 11-group, no pause, 6-group, long pause; (f) 4-group, no pause, 11-group, no pause, 6-group, long pause, and so on.

This table of actual observations shows clearly that a quantitative expression can be applied to each group of a complex. It should be noted at this point that these unitary groups maintain their identity for a long period of the life of the organism. One evidence for this which can be gained by studying the table is that a group does not recur immediately; a recuperation pause of about fifteen seconds intervenes between two executions of the group.

According to the previous naming of the group-complexes, the significances of the various groups of the table would be somewhat as follows: (a) the lizard takes 11 steps, grasps an object which is fast, bites it 6 times, and makes a long pause; (b) 11 steps, grasps a twig which it bites 6 times, long pause; (c) 13 steps with the twig still in its mouth, short pause; (d) 11 steps farther with the twig, long pause; (e) 11 steps with the twig, bites it 6 times, long pause; (f) it moves the twig about on the earth 4 times, takes 11 steps farther, bites the twig 6 times letting it fall from the mouth, long pause; (g) without the twig it moves the head about on the earth 4 times, takes 11 steps toward the building place, short pause; (h) 13 steps toward the building place, and since this is only five steps away, it goes eight steps beyond it, long pause; (i) it moves the head against the bare ground 4 times, walks 13 steps farther, long pause; (j) it moves the head about on the naked earth 4 times, takes 13 steps, long pause; (k) 13 steps, lands on a large number of leaves without seizing any, long pause; (l) it moves the head about on the earth where no nest is, 13 steps, short pause; (m) 11 steps, immediately bites a leaf 6 times, long pause; (n) moves the leaf about on the earth 4 times, takes 11 steps toward the building place, long pause; (o) 11 steps toward the building place, arrives there and chews the leaf 6 times, long pause; (p) it makes 4 movements in arranging the first leaf for the nest, and immediately walks away to fetch another object.

Utility of a group dependent upon its proper temporal position: Even though definite purposes were assigned to the

various groups of the lizard, some of them did not always serve the intended purposes merely because they occurred at inappropriate times. The same thing can be said of many of the potentially purposeful groups of any given nest-building animal. During the nest-building season, one can frequently make the observation that a particular group is at one time purposeful, at another time merely purposeless, and at another time even harmful in so far as it serves to damage the nest which is in the process of construction. The movements which a bird manifests in the nest-building season are none other than such groups of movements which are characteristic of a great number of animals, for instance, in a degree with the lizard. The observed movements of the lizard were apparently purposeless, and even so are many movements of the birds purposeless in the same sense; and indeed a few are generally harmful, while a sufficient number of them are, however, purposeful enough by nature and so frequently occur at such appropriate times that a neat nest may be eventually constructed.

The fact deserves emphasis that birds often work very crudely while building the nest. It is really astonishing how often a bird allows objects of building material to fall, apparently without responding further to them. A bird frequently stands on or walks among objects which it could well use in constructing its nest but suddenly runs or flies away without grasping any of them. I have observed the Blue Jay to tear the leaves, branches, and feathers from another bird's nest before it seized an object of the foreign nest and flew to the one which it had started; and it often seemed to arrange the objects on the foreign nest as if it were preparing to deposit its own eggs there, which it did not do.

Application to nest-building of birds: In order to parallel the cases of many birds, the lizard was permitted to lose one twig and to make some unnecessary movements. By redefining the groups of the lizard, I attempted to ascribe a definite purpose to each of them, but I was not entirely successful in this attempt merely because the order and time of occurrence of some of the groups were occasionally such that the indicated purposes were thereby defeated. For instance, the movements which were so defined that they could serve to arrange objects for the nest, fulfilled this purpose only once in the course of two hours. The fact, however, that some of the movements to which particular purposes were assigned did not serve the intended purposes makes our theoretical case correspond more nearly to the real conditions of nest-

building; for, as will later be shown by a specific case, potentially purposeful movements of actual nest-builders often occur at such times that the normal or usual purposes are thereby defeated.

Even if the activities of the lizard were as purposeful as I made them out to be, the groups involved are so few and far between that nest-building on the part of the lizard would be an extremely slow process. But when one considers an animal with innumerable group-complexes which are the characteristic movements of the head, tongue, beak, tail, feet, legs, etc., one may begin to understand how a complicated nest can be constructed in a relatively short time. It can be observed in the nest-building season that groups of a few group-complexes, such as those of biting and arranging, occur unusually often.

As to why particular complexes of movements manifest themselves and then disappear suddenly, sometimes for a long period of time, is by no means easy to explain. One might say the growing eggs in the body of the female is a sufficient stimulus to cause her to become active in the proper ways to build a nest, but many males aid in constructing the nest. One might then say that the sexual responses are accompanied by a sufficient number of others to cause a bird to build a nest; but this does not help us any, because we should now explain the more or less sudden appearances and disappearances of the sex-responses. In connection with our present problem, the following facts should be given consideration: (1) Purposeful, purposeless, and harmful complexes often appear suddenly, after some time disappear, and later, after days, weeks, or even months, they reappear.[2] (2) Bird's nests which are constructed quite late in the summer are generally less elaborate than those built in the early spring-time. (3) Birds frequently build nests apparently for no purpose, that is, no eggs are deposited in them even though apparently nothing occurs to prevent their doing so; they may be in and on the nest as frequently after it is finished as before, which fact would seem to indicate that they do not fail to deposit the eggs in the nest because some man or beast disturbs them. For some unknown physiological reason group-complexes appear and disappear.

Nest building of the Cariama (Cariama cristata): I shall next examine the activities of a bird in the nest-building sea-

[2] On page 261 of my article, Ueber einfache Bewegungsinstinkte, etc., already referred to, I reported a case of the sudden appearance and the later disappearance of a purposeless complex of a lizard. Many other similar cases have come under my observation.

son in order to compare these with the responses of the lizard which were previously presented. For this purpose, I have chosen a specimen of the Cariama, a native of Brazil and Paraguay. The particular bird observed was the male of a pair in a large out-door cage in the Zoological Garden at Berlin, Germany. Early in April I noticed that as this bird walked about in its cage, it occasionally bit in the air as if it were grasping an object. At times, however, it bit the bars of its cage, a branch of a tree, and even the naked earth. Sometimes it sprang and ran about rapidly, and it very often flew to a one and a half meter post on the top of which a wide shallow basket was fastened. On April 18, 1915, the following movements were observed: The bird stood at first motionless in the basket, shortly it began biting in the air as if attempting to seize something, and occasionally it seized, lifted, and then dropped certain branches which lay in the basket. It threw a stick out of the basket onto the ground, gazed for a few seconds at the sky, flew down, ran a few steps, seized a twig, walked to the post, grabbed still another twig which it had previously thrown out of the nest, flew back into the basket with these, beat them quickly here and there without releasing them, let them fall in the basket, bit and arranged them there, and then remained for many minutes by the side of the female which was then also in the basket. Presently the male, half-springing and half-flying, reached the ground, ran quickly to and fro in the cage, gazed for a while at the female as he walked round and round the post, and finally sprang and seized a twig which projected from the basket. This twig was unfortunately so badly tangled with the others of the nest that a great many were drawn out with it. But in spite of the fact that the nest was occasionally mutilated by the builder, a neat nest was eventually constructed.

Simple and multiple nests, or *serial character of nesting activities:* In the case of many birds, only very simple nests consisting of a single kind of objects, are constructed. In many cases, however, the nests are multiple ones; at first an ordinary simple nest is constructed and then on top of this one another simple one is constructed of another kind of building material, and so on until in cases the completed nest consists of a half dozen or more such simple ones. Owing to the fact that the building material and texture vary in the different cases of the simple nests, the analysis of such a multiple nest is easily made. The first simple nest of a multiple one may consist of large sticks; a second, of smaller sized sticks; a third, of mud; a fourth, of grass or fine roots; a fifth, of hairs or

fine fibers of plants; and a sixth, of feathers. I have observed considerable variations in the order of the simple nests which were constructed consecutively by the same birds. I have produced certain pronounced variations in the multiple nest by destroying it as soon as the first, second, or third simple nest was constructed. After a few days, in cases after only a few hours, the birds again started building either at the same or at some new place. In many cases, the new multiple nest did not contain any of the elements of the parts which I tore away; that is, the first one or two or three simple nests were omitted in the second attempt at nest construction. In a few cases, the birds continued to collect objects, but upon reaching the tree from which the previous nest had been torn, dropped these one after another until enough material for the characteristic multiple nest of these birds had been brought and dropped. When this happened, the birds generally waited a few days and then began a new nest which, when completed, included all the simple nests as usual.

The results of this experiment seem to indicate that the first simple nest is due to the presence of certain group-complexes, many of which disappear more or less completely giving way in each case to other complexes which enable the birds to construct the other simple nests in the characteristic order. In the case of a given variety of bird, such group-complexes manifest themselves in a particular temporal order, each one or several simultaneously occurring ones lasting for a few days and then disappearing for days, weeks, or even months. Just as a simple group of one or more elements cannot continue indefinitely, without the intervention of pauses for the structures that function, the complexes of groups cannot continue indefinitely when the pauses between the groups are made quite short; one group after another drops out until the greater part of the complex has disappeared. After the simple nests of a multiple nest are constructed, there are no complexes which might prohibit the female from sitting on the eggs or the male from singing. It must be borne in mind in this connection that sitting on the eggs is an activity as is that of building a simple nest; and it is more obviously the case that the singing of the male involves the manifestation of group-complexes analogous to those which serve to construct the nest.

After the eggs are hatched, or after the female has set on them long enough for them to be hatched, new group-complexes manifest themselves. In some cases — as with the English sparrow or the goose — these complexes serve to continue the construction of the nest after it contains the eggs.

The sparrow, for example, carries feathers and other objects of building material and completely covers the nest of eggs or young. If the young birds were to eat these objects of building material, we should say that the parent birds were merely feeding the young. It so happens that in the case of the sparrow, the young birds do devour a large number but by no means all of the objects brought to them. Those objects which the nestlings eat are insects, worms, and the like which would serve to form a covering for the nest if they were not devoured. The goose covers its nest with nearby objects every time it leaves it, and brushes these aside with its head, feet, breast, and wings when it returns. Many birds do not cover the eggs, and many do not even feed the young, which facts are to be contrasted with the facts that many birds build no nests or very simple ones while other birds build elaborate multiple nests.

Selection of the building site: My intention was to include in the present division of this article only a very general discussion of nest-building. I did not give a lengthy account of the process of selecting the building place; for such would have to be modified for almost every species of the nest-builders. Many birds construct their nests in chimneys, under eves of houses, in cavities in the banks of streams, cliffs, and trees which they frequent. By supposing that the lizard was to construct its nest in the neighborhood of the place where it usually sunned, I attempted to make its case typical of those of the birds just referred to. To a certain degree the lizard, in selecting a place for its theoretical nest, was also allowed to typify a large number of other birds which build their nests in trees; for it can be said that these birds, also, build their nests in the neighborhood of the places which they frequent. It should be remarked, however, that they do not frequent the particular mats of branches and the forks of trees which generally hold the nests, as much as they do other parts of the trees.[3] But this can be accounted for by the fact that, as a rule, only these portions of the trees are adapted to support the nests. It is evident from observing birds that it is not the sight of an ideal building place which stimulated them to begin the nest; they commence by carrying the objects of possible building material into the trees, often permitting them to fall to the ground merely because these do not happen to lodge on the particular limbs on which the animals happen to stand. Many birds can build their nests at only certain portions of the trees which are adapted to hold the collected

[3] Those birds which build swinging nests afford a possible exception.

objects; and generally, these places are located by the birds only after a number of trials. That this fact is not well known seems to be due to the circumstance that it is very difficult to observe a bird with sufficient scientific accuracy in freedom. It should also be mentioned in this connection that birds occasionally start two or three nests simultaneously and later destroy some of them to obtain the material for a single nest. It often happens that these places which are well adapted to hold objects of building material, contains a last-year's nest, in which case the old one may serve as a support for the new nest.

It is to be observed that when a bird flies to a given tree, it usually lights on a *certain* branch and then hops, walks, or flies to other parts of the tree. If the nest is already started at any time when the bird lights on this 'favorite' branch, it is stimulated by the sight of the collected objects to make the same group of movements which it performed in passing the first time or first few times from this branch to the building place. When it lights on some new branch of the tree, it may perform the same habitual group of movements in passing through the tree; and if this does not lead it to the nest, the bird may stand still for a short time — as if in a state of meditation — and shortly release the object which it has brought, or perform a new group of movements which may take it closer to the nest. The started nest becomes accordingly a stimulus to call forth in the bird certain responses which cause it to carry still other objects from its usual places of lighting in the tree to the place to which the objects were earlier carried.

C Defense of the Nest

Character of defense reaction: When a bird is approached by a person or some other intruder before it has begun to construct its nest, it usually flies away without emitting any special sounds or showing any signs of an instigated emotional state unless it be that of fear. But, after the foundation of the nest is laid, the bird shows signs of distress when approached. It may hop or flutter about in the neighborhood of the nest, all the while crying or at times even attacking the intruder. This activity of distress, like all other activities, does not continue indefinitely. The bird eventually shows less signs of emotion, in that it cries less frequently and finally leaves the nest entirely. If the intruder remains near the nest until this happens, it is usually the case that the bird 'quits the nest,' that is, it responds to it no further.

If, after a long pause, the bird returns after the intruder

has left, it may respond to the nest somewhat as usual, but also simultaneously to the intruder as formerly. In the absence of the intruder, however, the emotional state of excitement is not as great as in his presence; but it is frequently observed that when the bird does return to its nest the first, second, or third time after the intruder made his appearance, it cries somewhat as it did the first time in the presence of the actual intruder. Upon the return to the building place, the nest alone serves as a comparatively insignificant stimulus to call forth a large number of the responses which were previously called forth by the combination of nest and intruder, and which became associated in a temporally superimposed order while the bird was being stimulated by this heterogeneous stimulus pattern — in short, a fraction of the objective stimulus which previously affected the bird now calls forth fairly distinctly the previously established pattern-response. Such is generally the case if the bird returns at all before it has completely 'quit the nest.' In some cases, the bird may, while responding to the intruder in his absence, even mutilate the nest which it has built. I have occasionally observed birds which, upon returning to the nest after the intruder was no longer visible to them, broke their own eggs or slayed the young.

With a few birds, the unusual state of powerlessness or merely behaving exceedingly awkward is manifested when an intruder approaches them. As a rule, such actions can be observed only when the nest is entirely constructed and eggs or young are in it. Also, such actions are to be observed in the complete absence of the nest but always when the parent bird is with the young. As to whether the bird becomes unusually powerful or unusually powerless, depends upon the nature of the responses which are at the time called forth simultaneously; if the majority of them are allied, the animal may be temporarily powerful, and if the majority of them are non-allied responses, it may be temporarily powerless.

It is always to be noticed that after the parent bird leaves the nest or young for a considerable distance, it ceases to fight or even to walk or fly awkwardly. After it has gone a considerable distance from the nest or young, it responds to the intruder by flying away, as at ordinary times; it does not respond so strongly to the combination of nest or young and intruder when the nest or young are absent. At a later meeting of the same intruder, birds are frequently observed to respond to him somewhat as they did to the pattern-stimulus of nest and intruder or young and intruder. This corresponds to a bird's responding to the nest as if to the combination of nest and intruder. In each case, a part of the previous stimulus

calls forth many responses of the pattern-response which was previously established by the combination of nest and intruder.

Reaction against intruder dependent upon degree of completion of nest: This subject has been touched upon in the foregoing paragraphs, but a more systematic discussion of this point seems advisable. While carrying the first few objects of building material and arranging these in the tree, certain habits become established. These habits are groups of one or more complexes which for some reason or another appear at this particular time and which, being called forth frequently by a large number of external stimuli, are on the road to temporary disappearance. The intruder together with the part of the nest which is constructed, serve as a pattern-stimulus to call forth a very large number, if not all the groups of the complexes simultaneously. The nest serves to hold the bird in the vicinity of the building place in spite of the presence of the intruder; and the intruder serves to cause the bird to respond in a very large number of ways in a relatively short time. As was previously emphasized in the present article, any act of relatively short duration can recur only after the lapse of an adequate recuperation pause for the organic structures that function to produce the elements of the response. It was also pointed out that if the adequate recuperation pause is in any case made as short as possible, the response will ultimately occur much less frequently than before the animal was subjected to this treatment. Accordingly, when a large number of the defense-responses occur simultaneously — and the remaining ones in a rapid serial order — and the intruder remains present until the groups begin to occur very infrequently, the bird naturally ceases for the time being, if not permanently, to respond in the excited way to the combination of nest and intruder.

If two or three simple nests of the multiple one have been constructed, it is much more difficult to cause the animal to desert the nest permanently. It is also to be noticed that the state of excitement which an intruder can then cause in the bird is correspondingly greater than that which is manifested after only the first few objects have been collected and arranged. This is really what one should expect, because, when the nest has neared completion before the intruder appears, the bird is molested only after several complexes — those necessary in the construction of the various simple nests of the multiple one — have come into play. We should not forget that these complexes did not disappear completely but should remember that after a time the groups of the complexes

only occurred less frequently than when they were serving the purpose of nest-construction. The groups of the different complexes can still be manifested, and of course simultaneously, provided the stimulus is heterogeneous enough for this purpose. It is important that we consider in this connection only those complexes which have shortly before appeared and then apparently disappeared; for, while any given complex was the predominating one, its various groups became highly habitual and did not cease entirely to be habits. Accordingly, in view of the supposition that a habit-group is only an instinct-group which is called forth by a number of accidental stimuli as well as by the original most adequate stimulus for the response, we may suppose that a given group of an apparently disappeared complex is more likely to be called forth by the combination of nest and intruder than if the complex had never been a predominating one. If a group has never been habituated, or, if it has been a long time since this happened, such a pattern of stimuli, as that of the nest and intruder might possibly not contain the proper or adequate stimulus for calling forth the initial element of this group directly. As the building progresses, the number of groups of the various group-complexes which appear and disappear in a serial order, and which the combination of nest and intruder may later call forth simultaneously, increases to such an extent that the emotional state of excitement produced by the heterogeneous pattern is much greater than one which the same intruder could help to instigate during an earlier stage of nest-construction.